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Innovation and Commercialization in Atlantic Canada

Research Project

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The views and opinions expressed in this report are those of the authors, and include some opinions gathered from some stakeholders in the Atlantic Canada region but reported here anonymously. The authors make no claim to represent the opinions of the Atlantic Canada Opportunities Agency (ACOA) or any other government or research institute or organization in Atlantic Canada.

Executive Summary

Change is necessary in order to strengthen Atlantic Canada's economy and insulate it from market fluctuations and the problems of scarcity associated with a natural resource based economy. Innovation and commercialization are becoming increasingly important to the sustainable future of this region.

The four provinces of Canada's Atlantic region face several challenges in achieving their competitive potential. Advancements in communications and information technologies can remove some of the region's barriers associated with the small population base and geographic distance from major markets. Nevertheless, growth of a knowledge-based economy that either capitalizes on existing natural resources or supports new industry sectors will require significant changes in culture, attitudes and approaches to innovation and commercialization. With only a small foundation and infrastructure upon which to establish this new economy, Atlantic Canada must build partnerships and collaborate more than ever before.

In the Speech from the Throne in 2001, the federal government addressed the importance of improving the nation's research and development (R&D) performance in order to foster a more innovative economy. In addition to increasing R&D, the federal government's innovation agenda is based on developing a highly skilled work force and a positive business climate. In regions with strong economic performance, industry creates the *pull* for innovation and commercialization. It creates demand for R&D, provides funding, conducts a majority of the R&D work, and capitalizes on the outcome. This is a key engine of economic development. In more innovative economies, the ratio of industry applied R&D is at least three to four times that of university R&D, and twice that of universities and governments combined. While the federal government is committed to doubling federal expenditures on R&D, the Speech from the Throne also recognized the role to be played by the private sector in improving Canada's R&D performance to among the top five countries from its current 15th place ranking by 2010.

There is a perception that levels of university R&D in Atlantic Canada are low compared to the rest of Canada or the United States. This is true, but it is not the greatest competitive disparity influencing innovation. Ratios between university and industry R&D are the reverse of most innovative economies, with university research accounting for almost 3 times that of industry R&D. The region represents about 7.7% of the Canadian population, yet only 1% of the nation's total industry investment in R&D is spent in Atlantic Canada. Universities in the region are much closer to the national average, receiving 6.7% of the investment spent in Canada on university R&D. Atlantic Canada requires an aggressive investment program, with funding increases focusing predominately on industry-driven applied R&D. An appropriate balance of relative capacity in each of the stages of the innovation process is also critical to accelerating competitiveness and creating a robust and innovative economy.

Thus, the needs of the Atlantic region are two-fold: to build industry capability to undertake applied R&D, and to increase industry's receptor capacity for the innovations developed by universities and other institutes undertaking applied R&D in the region. On the former, this will require significant investment in physical and intellectual

infrastructure, and as much as a seven-fold increment in industry R&D. In the near term, this is well beyond any reasonable industry capability. However, leveraging of investment and activity will help to significantly boost innovation and commercialization activity. In 1998, Atlantic industry performed $95 million in R&D, and directly funded $89 million. Therefore, it leveraged only about 6% of its applied R&D from other sources. By comparison, nationally, industry invested $6.8 billion in R&D and conducted $9.1 billion, a leverage ratio of 26%. There is substantial support available from federal innovation programs, however, industry in Atlantic Canada has not leveraged it at a level proportional with industry elsewhere in the country. This is, in part, a function of industry structure in the region, with few large firms and a lower level of applied industry R&D.

Another means of leveraging industry investment is by capitalizing on existing physical and intellectual assets. Thus, universities and federal laboratories must take up the challenge to increase innovation and assist with commercialization on behalf of industry during a transition period. The region must build on its existing pinnacles of strength – people, universities and research centres, agencies, and key industries. Innovation may provide added value to existing successful natural resource based sectors in order that they may increase their international competitiveness. However, strategic investments in innovation and commercialization related to knowledge-based industries will offer the greatest potential to transform and sustain the economy in the long-term.

The Atlantic Provinces have invested in a few incubators to facilitate small business development and university/industry relationships. Incubators assist the transition to commercialization from innovation activity in universities and other research facilities. Successful aspects of applied research alliance models should be replicated along with the introduction of applied research councils to foster applied industry research and encourage stronger university/industry collaborative research relationships. The overall region may be better served by augmenting the skills, staffing and services in a few university/industry dissemination programs and liaison offices, and establishing partnerships to serve more than one institute.

All stages of innovation and commercialization activity in Atlantic Canada require additional capacity and investment. The Atlantic Investment Partnership, an infusion of $410 million over 5 years via the Atlantic Innovation Fund (AIF) and National Research Council (NRC) to the region's innovation system will assist with the challenge of finding adequate sources of funding, but perhaps the greater challenge is to target funding to key areas of strength with the best opportunity to stimulate sustainable economic development. University expertise, assets, capabilities and partnerships will be essential. University willingness to be engaged in more applied research will be critical. The success of an Atlantic innovation strategy may weigh in the balance.

Yet, perhaps the most important challenge for Atlantic Canada is to develop the common vision and the collective will to create a culture of innovation. "...innovations are a function of the quality and constructiveness of relationships within its communities, based on an overall common vision."[1]

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[1] An Innovative Society and the Role of Government, Report of the Auditor General of Canada to the House of Commons, 1994, Chapter 5, page 9.

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Section 1: Introduction to the Innovation & Commercialization Process

The following report presents a region-wide analysis of the innovation and commercialization landscape across Atlantic Canada with particular emphasis on the links to research facilities and post-secondary institutes in the region.

This study builds upon recent research[2] on Research and Development (R&D) competencies in Atlantic Canada, and examines the current situation in the region with respect to innovation and commercialization practices. It addresses areas of strength and weaknesses, and identifies opportunities for improvements. It examines relevant best practices in innovation and commercialization, and lessons learned from other jurisdictions that may be applicable to Atlantic Canada.

The goal of this paper is to assist the Atlantic Provinces in identifying ways to improve the economic benefits to the Atlantic region via well-focused research and development (R&D), innovation and commercialization programs.

1.1 Terms of Reference

This report results from a proposal submitted to the Atlantic Canada Opportunities Agency (ACOA) by the authors. The terms of reference outline the following objectives[3]:

- Examine current technology commercialization practices, the process, existing initiatives contributing to the process, and stakeholder views in Atlantic Canada.
- Examine best practices in technology commercialization and lessons learned from other jurisdictions recognizing the uniqueness of Atlantic Canada.
- Identify opportunities for improvements within each major component of the innovation and commercialization process including strengths and weaknesses.
- Provide an overall picture of the strengths and opportunities in the region's research infrastructure, building upon R&D competencies in Atlantic Canada.

The innovation and commercialization process is very complex and has many inter-related elements. Various aspects of each of these objectives and outputs are addressed in whole or in part in several sections throughout the report.

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[2] Studies include the research Reports of the Maritime Provinces Higher Education Commission (MPHEC). For complete list of research reports reviewed for this study, see Appendix A: References.

[3] For more complete Terms of Reference contact ACOA, Head Office.

As there is no generally accepted (and comprehensive) representation of the process in the literature, the study has selected a single respected representation as a common basis for the analysis and assessment (see Figure 1 and 2 below).[4] This provides continuity throughout the report and a benchmark for reference in future.

1.2 Scope of Work

Research and analysis for this report focused on a review of the competitive status of innovation and commercialization in the Pan Atlantic region, and consisted of the following:

1. Preparation, dissemination and review of a set of questionnaires to assess regional views.
2. Review and mapping of existing infrastructure and contributions to the innovation process in each Atlantic Province and in the region collectively.
3. Mapping of national programs and infrastructure in other Provinces.
4. Review of reports on, or relating to, innovation and commercialization in the Atlantic Provinces, and in other regions of Canada and the U.S.[5]
5. Interviews, presentations and correspondence with stakeholders from the region.
6. A regional SWOT (strengths, weaknesses, opportunities and threats) analysis.
7. Identification of regional pinnacles of strength of the knowledge-based enterprise (KBE) sector, and review of best practices from other jurisdictions.

1.3 Key Factors

There is no generally accepted prescription for innovation and commercialization strategies within provincial/state, regional or national economies. Infrastructure, regional demographics, research and development and industry capacity are all different. Additionally, information is limited on the statistical history of generally accepted parameters that lead to success. There is no generally accepted ratio or balance of effort among the various factors in the process that better serve one set of economic circumstances rather than another. Yet there are hints. There are organizations that track certain types of statistics in an attempt to build a knowledge base that may facilitate comparisons. For example, the Association of University Technology Managers (AUTM) from the United States tracks commercialization of university research; Statistics Canada tracks economic and R&D-related data; and the Organization for Economic Cooperation and Development (OECD) tracks innovation capacity indicators. Among these, there is some consensus regarding best practices, and these provide a few 'rules of thumb' within the process.

This study attempts to make best advantage of these types of perspectives and lessons learned from other jurisdictions. It assesses the absolute and relative balance of capacity required for the entire process, for each of the stages in it, and for the Atlantic regional

[4] See Figure #2 of this document, Alan Preston, MIT Technology Transfer literature (date unknown).
[5] Partial list of literature and reports reviewed is cited in Appendix A: References.

context. Different perspectives will provide different prescriptions. Therefore, this is a discussion document. It attempts to set out observations regarding larger strategic structural issues and seeks to find both absolute and relative critical mass levels of effort commensurate with the needs of the Atlantic economy.

A regional SWOT (strengths weaknesses, opportunities and threats) analysis has been prepared which integrates much of this information. Several key factors that appear to weigh most significantly in devising a regional strategy are briefly summarized here:

1. Common basis for understanding the process and balance of effort within it.
2. Relative ratios of R&D performance in knowledge-based economies.
3. Critical mass levels of R&D investment in public and private sectors.
4. Leverage capability/uptake of national programs.
5. Best practices.
6. Social sustained investments versus economic self-sufficiency investments.
7. Pinnacles of strength and clusters.
8. Tax systems and incentive based investments.
9. Culture, attitudes, partnerships and phasing.

The perspectives presented in this brief that pertain to structural and economic issues may be in reasonable orders of magnitude to facilitate increased innovation and commercialization in Atlantic Canada. However, the need for cultural and social *will* to effect necessary changes is perhaps many orders of magnitude greater. This remains a crucial challenge. There is no simple way to quantify this, it is of the highest importance and it is essential for success.

1.4 Common Basis for Understanding the Process and Balance of Effort

There are several different representations of the rather complex innovation and commercialization process, and various measures of innovation capacity. This work provides a single integrated representation as a common basis for discussion and evaluation.

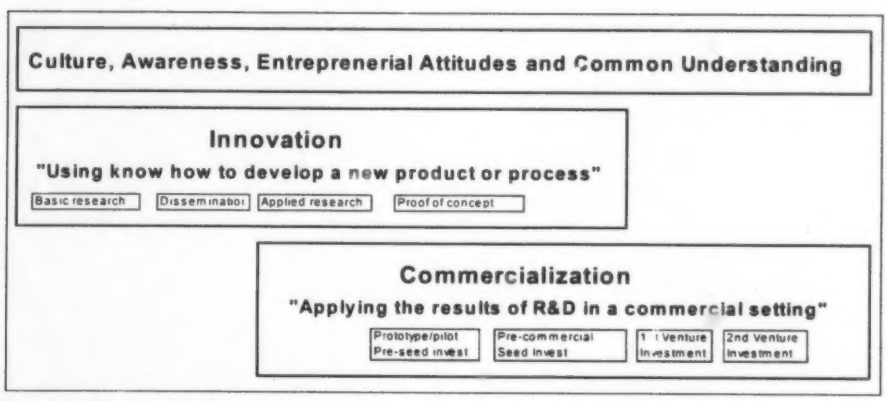

Figure 1: The Innovation & Commercialization Spectrum

Major considerations and stages include:

(1) **Culture, awareness, entrepreneurial attitudes and common process understanding** (which involve all stages and are integral throughout the entire process);
(2) **Innovation** including basic research, applied research, knowledge/technology transfer (dissemination), proof of concept and
(3) **Commercialization** including industry receptor capacity development, prototype and commercial product development, pre-seed, seed and venture investment.

There is potential for confusion between the terms *innovation* and *commercialization*:

> *The difference between commercialization and innovation can be a bit cloudy. Commercialization and innovation tend to be used interchangeably so the difference needs to be clear. Commercialization has more to do with taking R&D from the lab to the stage where it can find application in an industrial setting. Actually using this know how to develop a new product would be innovation.*[6]

For success, this must be an integrated process with critical mass capability at all stages. Nevertheless, relative capacity among and within in each of the stages will be different. There are also many different stakeholders, often with different and competing objectives. In the following sections we discuss the appropriate balance of the stages in the process for Atlantic Canada under the assumption that the overall Canadian, US and international economies have appropriate ratios for effective innovative capacity.

1.5 Stages of the Innovation and Commercialization Process

The following diagram[7] illustrates average relative allocation of funding in the United States university system, and indicates investments versus return on investments (ROI) throughout the stages of the innovation and commercialization process. Consideration to each stage in the process must be given in order to identify and understand the following:

1) General trends relating to both indirect and direct types of investments and return on investment for various stages.
2) Levels of general funding availability in each stage of the process, and which stage(s) has/have funding deficiencies.
3) Types of barriers and challenges to the efficacy of each stage, and to the overall process.
4) Existing strengths (people, process and infrastructure) and performance measures for each stage.
5) Types of best practices, investment structures and models that may enhance the performance at each stage and in the overall innovation and commercialization process.

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[6] UPEI questionnaire respondent to this study, August 2001.
[7] See Figure #2 of this document, Alan Preston, MIT technology transfer literature (date unknown).

Both in Canada and the U.S., the initial basic research and dissemination stage, (A in Figure 2 below), traditionally receives major research investments from the federal government. However, dissemination receives limited, if any, federal support, and provincial support in only a few jurisdictions. The applied research stage (B in Figure 2 below) may be funded by provincial or state governments, as well as by industry. Proof of concept, prototype and seed stage investments (C, D and E respectively below) are traditionally very low relative to the other stages, unpredictable, and from no particular source. This is typical of most jurisdictions.

In the Atlantic region, the basic research stage (A below) generally receives research support approximately equivalent to only one major Canadian university. Therefore, the region is placed at a competitive disadvantage with the rest of Canada. The Expert Panel on the Commercialization of University Research recommended that an additional 5% of federal research funding be invested for the dissemination of research outcomes from universities to industry.[8] Dissemination is an integral part of investments in basic research, facilitating economic benefits to society of university research.

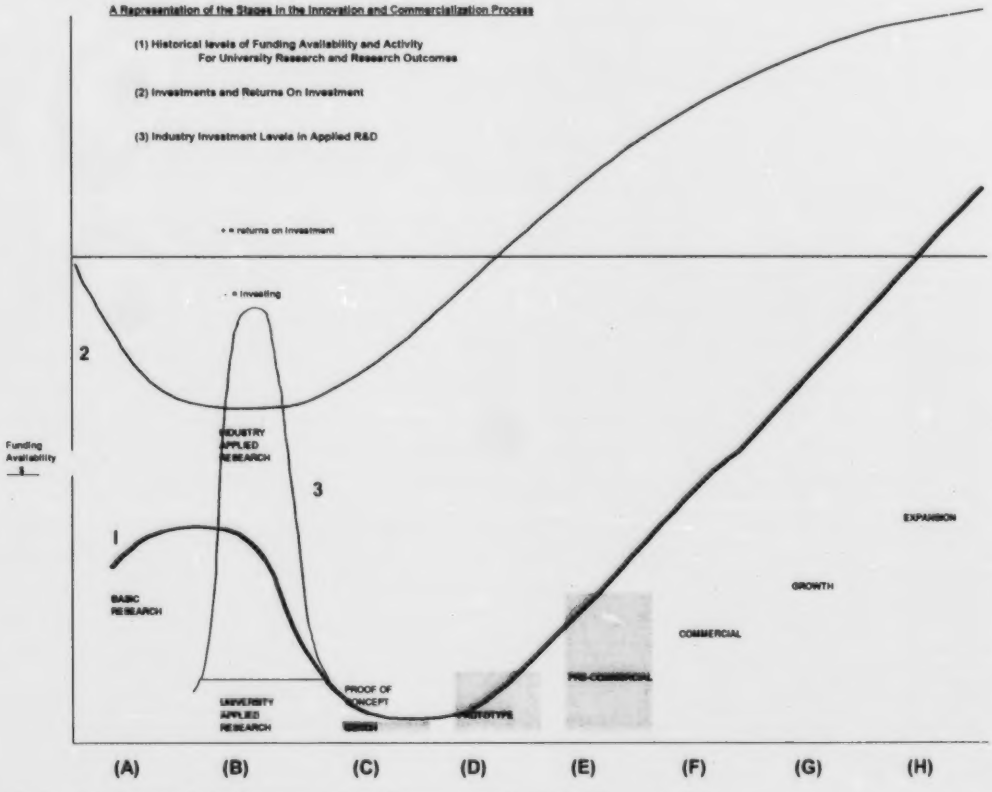

Figure 2: Stages of the Innovation & Commercialization Process

[8] Public Investments in University Research: Reaping the Benefits. Report of the Expert Panel on the Commercialization of University Research Presented to: The Prime Minister's Advisory Council on Science and Technology May 4, 1999.

The Atlantic Canada Opportunities Agency (ACOA) has made some short-term investments in dissemination programs in each of the provinces. However, this funding has been modest and not designed to be sustained despite the need for long-term, continuous investment in dissemination of knowledge and innovations. Largely resulting from fiscal restraint, provincial government support for university research and dissemination, and for matching federal funding (including the Canadian Foundation for Innovation), has generally been lacking in the Atlantic region. However, it is strong in other parts of Canada including British Columbia, Alberta, Ontario and Quebec, and this places Atlantic Canada at a disadvantage.

There are widely varying levels of provincial government and industry investment across Canada in applied research (B) as well as investments in each of the stages between (B) and (E). In the Atlantic Provinces, investment in these stages has been very low or absent, resulting in constraints on the development of industry R&D and receptor capacity.

As illustrated in Figure 2 above, the lower solid line (1) represents general levels of funding availability across the process (in the U.S.). Of particular note, the levels of applied research (B) are very low in universities but are much more significant in industry in innovative economies. This industry applied research contribution is shown by line (3) in the Figure and is discussed in more detail in this paper.

The upper line (2) relates to the investments and return on investments across the innovation process. Different types of investments are required at different stages in the process. In the earlier stages – stages (A), (B), (C) and portions of (D), these may be considered sustained social (government) investments that are ideally long-term investments, and for which there is often no immediate returns directly to investors (the public).

Returns on these investments are by way of successful enterprises that generate jobs, product sales, service revenues and taxes. Unfortunately where these investments are limited or lacking, there will be severely diminished deal flow in the number of research outputs, and discontinuity in the process. Existing government programs face many challenges in making these types of social investments that cannot be self-sufficient or provide returns in the short term. The National Research Council Industrial Research Assistance Program (NRC/IRAP) has been most responsive in this respect.

The following Figure 3 illustrates several general categories within the innovation and commercialization process that require a critical mass of investments. These include:

(a) Understanding, awareness, networking and attitude change;
(b) People expertise and creativity;
(c) Knowledge transfer and dissemination;
(d) Receptor capacity and capability; and
(e) Venture investments and a positive re-investment climate.

The first five of these culture understanding, awareness, networking and attitude change, are primarily social sustained types of investments that cannot be self-sufficient. Within each of these categories, is a requirement for investment in people with both the expertise and the drive to push innovation forward and facilitate industry relationships.

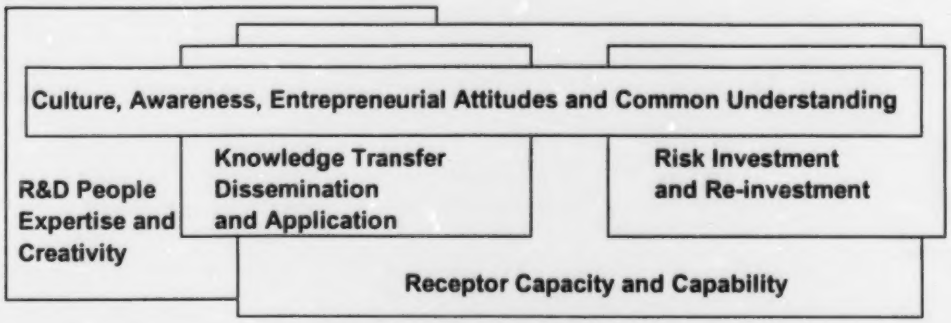
Culture, Awareness, Entrepreneurial Attitudes and Common Understanding
Knowledge Transfer Dissemination and Application
Risk Investment and Re-investment
R&D People Expertise and Creativity
Receptor Capacity and Capability

Figure 3: Categories of Investment & Activity in the Innovation & Commercialization Process

Section 2: Analysis of Strengths, Weaknesses, Threats and Opportunities

As a basis for assessing strategic options, we briefly summarize key SWOT (strengths, weaknesses, opportunities and threats) for the region as a single unit, based upon reports and feedback from the questionnaires and interviews.

2.1 Strengths and Assets

Major factors contributing to innovation capacity include R&D infrastructure, information infrastructure, financial and business climate and human and social capital.[9]

Atlantic Canada has a good foundation of researchers and professionals with expertise in universities, colleges and in a few emerging businesses. It has good research laboratories, good information networks and several recognized centres of excellence. While regional R&D levels are low, Nova Scotia has one of the highest per capita investments in R&D in Canada. Irrespective of marginal investments throughout the region in university/industry liaison and research dissemination activities, the industry investment in university R&D approximates 11% in all provinces, almost equal the national average of 11.8%. This is a small but major strength. There is also a good percentage of foreign investment in portions of Atlantic Canada's R&D activity, attesting to the region's ability to achieve international excellence.

There are very good agencies that facilitate university/industry services, innovation and design. These include Atlantic Veterinary College (AVC) in PEI, the new product engineering centre at Université de Moncton (Genieo) and the university/industry liaison offices, Telecom Applications Research Alliance (TARA) and the Global Information Networking System (GINI) in Nova Scotia, and the Canadian Centre for Marine Communications (CCMC), the Canadian Centre for Fisheries Innovation (CCFI) and Genesis in Newfoundland. A few --but very few-- industry/university agencies facilitate the entire spectrum of innovation and commercialization sector services. Genieo and TARA are two examples, elements of which are excellent. The concept is strong and successful, mirroring successes in other jurisdictions. They are made in Atlantic Canada. They integrate the two cultures of industry and university, employing university research with the knowledge skills and talent to facilitate innovation and involving local senior industry and financial capability. They are world class.

2.2 Gaps in Innovation System

Gaps in innovation capabilities presently outweigh strengths and assets. In terms of the most important asset — people — there are many challenges. While there is an increasing propensity to become more entrepreneurial, there is still much to be done to foster a

[9] Total Development Fund: R&D/Innovation Strategy. Department of Business, New Brunswick, OECD Innovation Capacity, June 28, 2001.

culture of innovation and entrepreneurship in the population at large. Few entrepreneurial immigrants come to the region to invest and live, and many of the best students leave for other pastures. Measures are insufficient to reduce brain drain and to induce brain gain. Cosmopolitan centres that attract and retain high technology companies and personnel are few. Personal income tax rates do not facilitate competitive international salary levels and risk investments, and regional tax systems fail to attract significant levels of larger firms to conduct R&D in the region. Tax credits in most of the Atlantic Provinces are underutilized, and changes to R&D incentives are under consideration.

There are weaknesses and gaps in the innovation process, such that continuity, which is necessary for success, is lacking. Awareness of the process, and common understanding, is absent. There is no major social investment in applied R&D, no regional science council to catalyze increased industry investment, and, except for TARA in telecommunications (in one province), no continuous facilitation of the process in key KBE sectors. There are a few university/industry liaison offices, but these are understaffed and under funded. Trust relationships with university faculty need to be redressed, as does the fractionated delivery of dissemination services within parts of the university system. There is little emphasis and few mechanisms for ready disclosure of university research results, and scarce means for aggressively accelerating industry/university relationships.

Atlantic Canada does not have critical mass in many of its research and innovation systems, and infrastructure and industrial capacity are also limited. Therefore, it does not or is unable to, access many national programs. Hence its leverage of other investments from existing federal programs is extremely lacking. Industry funding is matched only 6% as opposed to 26% in the rest of the country.

Many of the agencies in the region have unrealistic performance measures. They all have scarce resources, and almost all compete instead of cooperating effectively with each other. Yet, without partnership and concerted effort, the region as a whole will find it very difficult to compete internationally in innovation.

2.3 Opportunities and Threats

There is recognition among many stakeholders in the region, as well as in senior levels of the federal government, that Atlantic Canada requires both an innovation strategy and sustained investment in order to accelerate innovation in the region's economy. This presents a significant opportunity. Thus, the greatest threat is to fail to articulate a solid and successful strategy that converts this recognition into success. There are programs and funds to assist with research chairs, innovation infrastructure (Canadian Foundation for Innovation) and strategic research (Natural Science and Engineering Research Council and National Research Council), as well as increased university research, increased regional innovation (Atlantic Innovation Fund), and investments in community development. If Atlantic Canada matching contributions for several of these (especially CFI innovation funding) is not provided, regional competitiveness is further threatened and a significant opportunity for additional investment is lost.

A weakness related to the low level of leverage on industry R&D performance also presents an excellent opportunity. With diligence, the 6% leverage on existing industry investments can be expanded towards the 26% Canadian average by accessing existing federal and provincial programs. There are also indications that there may be additional federal support for commercialization of university research.[10] The perceived (and real) weakness in university research dissemination in the Canadian innovation system may be addressed by allocation of up to 5% of federal granting agency R&D funding in the future. This will benefit Atlantic Canada and provide an opportunity to leverage this investment and reconcile regional infrastructure. It will not resolve the need entirely and, if it does not materialize from some source, the region will be negatively affected.

There are several major threats relating to culture, attitudes, partnerships, critical mass and patience. Effecting an attitude change towards innovation and knowledge-based employment, rather than resource-based jobs and wage support is among the most important challenges for parts of Atlantic Canada. The region lacks a critical mass of industry innovation and commercialization receptor capacity and partner relationships. If not resolved, competition for scarce resources and differing priorities within the region will constrain partnerships that are essential for regional success. The many demands for scarce resources will also raise pressures to fund a wide array of activities and projects, many of which may not provide a strategic and sustainable foundation for future prosperity. Diligence will have to be exercised to fund and focus on only the most promising programs in order to achieve significant impact in terms of innovation outcomes. Investment is likely best in a few major items in "big bites" to develop the critical mass necessary for sustained growth in a few key areas.

Not all investments may satisfy existing expectations. This will require some compromises, strong understanding and strong partnership. It will also require considerable patience since these investments must be long-term. The region must stay the course without seeing results or major gains for 7 to 10 years, as is consistent with innovation and commercialization timelines. Success will require sustained vision, resolve, commitment and patience.

[10] Public Investments in University Research: Reaping the Benefits. Report of the Expert Panel on the Commercialization of University Research. Presented to: The Prime Minister's Advisory Council on Science and Technology, May 4, 1999.

2.4 Summary SWOT Analysis

STRENGTHS	BARRIERS, WEAKNESSES & THREATS
❑ Small base of researchers and expertise in universities, colleges. ❑ Some good research laboratories with physical infrastructure for R&D. ❑ A few centres of excellence upon which to leverage development. ❑ Small base of emerging businesses. ❑ Some investment in incubators to facilitate small business development & university/industry relationships. ❑ Good percentage of industry investment in university R&D – indicates trust & ability to work together. ❑ Some foreign investment. ❑ Very good agencies facilitating university/industry collaboration in innovation and design (AVC, Genieo, GINI, Genesis and CCMC). ❑ A few applied R&D industry agencies facilitating innovation and commercialization services – e.g. TARA, Genieo. ❑ Advanced telecom systems remove geographic distance barriers. ❑ Relative proximity to US Eastern seaboard (high population & commercial/industrial activity). ❑ Recognition and commitment that Atlantic Canada requires an innovation strategy and sustained investment to accelerate innovation in its economy. ❑ A few good agencies to leverage for growth. ❑ Untapped leverage opportunities for matching funding from other national programs.	❑ Lack of sufficient critical mass of applied R&D for innovation & commercialization; not enough commercially oriented research. ❑ Lack of industry *pull* for R&D & industry receptor capacity. ❑ Lack of industry-based R&D. ❑ Lack of entrepreneurial activity & innovation in the culture. ❑ Brain drain and few innovators in the brain gain. ❑ Small research & industry base over significant geographic territory. ❑ Not enough industry/university agency activity throughout region facilitating innovation and commercialization services. ❑ Personal income tax rates weaken salaries --deters professionals from immigrating to the region. ❑ Regional tax systems and credits exist but uptake is limited or types of credits are unattractive to firms to conduct R&D in the region. ❑ Gaps in the innovation process – stages lacking sufficient activity. ❑ Insufficient social investment in applied R&D. ❑ No regional science council to catalyze increased industry investment ❑ No continuous facilitation of the process in key KBE sectors in any of the provinces. ❑ University liaison offices are insufficient in number, and lack staff, skills & funding. ❑ Weak trust relationships with university faculty. ❑ Inadequate dissemination & disclosure of university research results.

Summary SWOT Analysis (continued)

OPPORTUNITIES	BARRIERS, WEAKNESSES & THREATS
❑ Some programs assist with research chairs, innovation infrastructure (CFI), increased university research (CURE), increased regional innovation (AIF), strategic research (NRC) and investment in community development. ❑ There may be additional federal support for commercialization of university research, & adjustments to equalization payments to the region. ❑ Up to 5% of federal granting agency R&D funding may be available to assist dissemination of university research in to Canadian innovation. ❑ A few good leaders with vision. ❑ Opportunities to build partnerships, focus on strengths and build innovation & commercialization in a few target sectors.	❑ Limited means for aggressively accelerating industry/university relationships. ❑ Limited number of graduate level and Postdoctoral Fellow programs to retain/attract good graduates. ❑ Agencies & researchers have scarce resources & compete with each other for limited financial resources. ❑ Distance from major Canadian & US industrial/commercial centres. ❑ Weak economy, especially in the knowledge-based industry sector. ❑ Entrenched bias – socially & politically — towards resource-based economy & limited experience with KBE.

Section 3: Targeting & Developing Areas of Strength

Among the key problems in Atlantic Canada is the lack of critical mass of innovation and commercialization activity across all sectors. Thus, the following observations emphasize the need to target promising areas of strength, and to focus financial and intellectual investment in these areas by creating clusters of excellence. A shift in attitudes to a more positive alignment among the four provinces and individual research institutes should make way for partnerships and alliances that, together, create a critical mass of innovation and commercialization investment and activity. Leveraging pinnacles of strengths and harnessing the power of partnerships will assist with capacity building. However, significant growth cannot be achieved without greater allocation of funding resources to build industry research and receptor capacity in particular. Commitment to significant cultural and attitudinal change is also critical in order to foster a climate conducive to innovation and commercialization.

3.1 Pinnacles Of Strength

In Atlantic Canada, industry applied research has been confined to a few companies along with a small number of agencies and university related institutes. Genieo, TARA, AVC, GINI and a few others have produced successful economic outcomes. They incorporate:

(a) Strong applied research relationships and networks.
(b) University professor and student fellowships.
(c) Applied research.
(d) Local industry commercialization and investment.

These are applied research pinnacles of strength upon which to leverage growth of an innovation and commercialization economy.

Reinforce & support existing applied research pinnacles of strength to leverage and expand capabilities in a few key sectors.

Innovation may provide added value to existing successful natural resource sectors including agriculture, agri-food, fisheries, forestry and mining, in order that they may continue to expand and to increase their international competitiveness.[11] However, strategic investments in innovation and commercialization related to knowledge-based industries offers the potential to transform and sustain the economy in the long-term – even after some natural resources are depleted or have become less competitive. Emerging sectors in Atlantic Canada include aquaculture, biotechnology/pharmaceutical and medical technologies and products, environmental industries, ocean technology, oil and gas and, one of the most promising -- information and communications technologies. However, with limited funding and a small industry base, it will be difficult to become world-class in all of these sectors. Hard choices will have to be made.

Focus funding on a few key sectors; develop partnerships between research institutes, agencies & industry in the Atlantic Provinces.

[11] Internal Atlantic Canada Opportunities Agency (ACOA) research, 2001.

Selections of sectors and focus should be determined by Atlantic industry in partnership with government and universities that invest in the alliances. There are several major corporations that are long-term residents in Atlantic Canada. They may serve as pinnacles of strength contributing expertise and an asset base for a more innovative economy.

In addition to focusing on key industries or sectors and industry partners to develop pinnacles of strength, it is important to focus on the *people* who will attract industry investment, and bring the knowledge and expertise that will stimulate excellence in innovation and expansion of commercial activity. British Columbia has invested in acquiring and retaining the best research people who can create and support pinnacles of strength. Via its Advanced Systems Institute, the provincial government provides additional support for university research fellowships as well as funding for university/industry research that is usually matched by incremental leveraged investments from federal government research programs. The government and the Institute also provide resources for 'hunting licenses' to assist local universities in competing for the best researchers globally. This strategy has resulted in increased percentages of available research funding going to the institutions with excellent researchers, and has attracted and supported higher educated graduate students engaging in the research activities. This is a complement to the universities' industrial chairs that foster blending of industry and university expertise in B.C.

In other jurisdictions, such as Georgia, there are "Executive in Residence"[12] programs that are an extension of this concept. The Georgia Research Alliance, which is a strategic partnership of the state's business community, government and research universities, employs a variety of methodologies to attract investment and job creation to the region. In addition to the Technology Development Partnership (TDP) program, which invests in university-based research projects that have commercial promise and financial support from industry, GRA has an "eminent scholars"[13] program. "These research *stars* figure prominently in most of the major success stories. They successfully compete for a disproportionate share of funded research, attract the best graduate students and create the most interest on the part of companies."[14] In little over a decade, the GRA model has facilitated an 800% increase in research relationships between universities and industry, venture capital investment with 10 times the investment levels that existed in 1995, and technology related job growth among the top five in the US.[15] These measures have made significant contributions to building industry capacity for innovation and commercialization bringing together business, science and government to turn university research into important economic gains, among them new start-up companies, enhanced jobs and industry recruitments.

[12] Georgia Research Alliance website, http://www.gra.org, October 2001
[13] Georgia Research Alliance website, October 2001.
[14] Georgia Research Alliance website, October 2001.
[15] Georgia Research Alliance website, October 2001.

3.2 Clusters of Excellence

> *Since knowledge-intensive activities draw more heavily upon human capital than physical capital and social infrastructure that can be created anywhere, the challenge for Canada, competing against the inherent size advantage of the United States, is to create attractive opportunities for industrial clusters.*[16]

The Atlantic Provinces have invested in a few incubators to facilitate small business development and university/industry relationships. All have strong NRC/IRAP and Industrial Technology Advisor (ITA) linkages, as well as reasonably strong small business development, loan and investment programs, and some tax-based programs. These incubators can be critical to the transition towards more commercialization from innovation activity in universities and other research facilities. With each province having invested in telecommunications capabilities, geographic distance between centres of activity does not preclude clustered initiatives and partnership in a *virtual* community.

Notably absent from the Atlantic innovation infrastructure are applied research councils. Several provinces have instituted these types of agencies to foster applied industry research and to encourage stronger university/industry collaborative research relationships. In BC, a review of the BC Science Council provides evidence of significant rates of return on these investments.[17]

Establish applied research councils in key centres to foster increases in the level of industry applied R&D, especially in SMEs.

The TARA applied research alliance model has shown potential within one sector (telecommunications) and one province. Fifty percent (50%) of its functions are long-term *social* investments in networking, awareness, students and industry/university relationships. The other functions serve as economic development investments, however they do not provide short-term returns and must be continuously reinvested to develop the SME capacity of the sector. Both large and small corporations contribute significant industry investment in the alliance, primarily in Nova Scotia. This is the type of partnership and focus necessary to drive a regional innovation and commercialization strategy.

Leverage successful aspects of applied research alliance models – expand them to other provinces/centres, and adapt them to other key sectors with high growth potential.

Numerous Atlantic entities are involved in university/industry liaison and dissemination. In Nova Scotia (at or near Dalhousie University) agencies include NU-TECH, GINI, Dal BioMed, Life Sciences Development Association (LSDA), TARA, InNOVAcorp, and Genome Atlantic. In Newfoundland, associated with Memorial University, are Genesis,

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[16] Globerman, Steven (Western Washington University, The Location of Higher Value-Added Activities, Occasional Paper Number 27, Industry Canada Research Publications Program, April 2001).

[17] An Outcome Evaluation of the Technology BC Program. Prepared by the Science Council of BC, http://www.scbc.org/inin_inli_pu.html. PDF file, released September 2001.

The Canadian Centre for Marine Communications (CCMC), the Canadian Centre for Fisheries Innovation (CCFI) and the Canadian Centre for Core Ocean Research (C-CORE). In PEI there is the PEI Food Technology Centre, AVC Inc. and Biovectra, and in New Brunswick there are several service centres for research and development liaison, including the Research and Productivity Council, Genieo, and BioAtlantech. There are also numerous Federal research laboratories. These represent areas of particular R&D strength in key sectors, and they may be appropriate centres of excellence around which to develop clusters and partnerships with industry in order to increase levels of applied R&D and to expand dissemination capabilities.

In most other regions of Canada, provincial governments have invested in the innovation dissemination and university/industry liaison process, yet New Brunswick is the only province in Atlantic Canada with significant investment in these activities. In addition to universities, there have been some modest ACOA investments in the process, but these have been short term and not sustained. Significant additional resources from AIF, NSERC or other sources will also be required, and a regional partnership --such as western Canada's Westlink but 'made in Atlantic Canada' -- will strengthen capabilities and help facilitate a critical mass of activity. "It may be ineffective for a small, open economy to encourage more than one cluster to develop in specific industrial areas."[18] An Industry Canada report on clustering recommends "allowing and encouraging patterns of regional specialization that maximize the nation's welfare, rather than that of individual provinces."[19]

3.3 Partnerships and Alliances

Atlantic Canada represents about 7.7% of the Canadian population, yet only 1% of the nation's total industry investment in R&D is spent in this region. However, the region receives 6.7% of the nation's investment on university R&D, which is much closer to the national average. With the exception of Nova Scotia, overall R&D investment in Atlantic Canada is less than half of the national average. However, despite deficiencies, lack of resources in university/industry technology transfer or liaison services and very low levels of R&D undertaken by businesses, industry funds university R&D in each of the four Atlantic provinces (including PEI with the lowest total R&D in Canada) at a level that is only about 1% lower than Canada's average of 11.8% (of the total R&D funding in Canada from all sources).

This pattern shows strong and positive tendencies towards industry/university research relationships. These relationships should be further exploited as industry R&D levels and receptor capacity are considerably enhanced.

Leverage industry-university relationships.

[18] Globerman, Steven (Western Washington University, The Location of Higher Value-Added Activities, Occasional Paper Number 27, Industry Canada Research Publications Program, April 2001).
[19] Globerman, Steven, April 2001.

Despite the fact that (in 1998), Atlantic industry performed $95 million in R&D, and directly funded $89 million, it was only leveraged about 6% of its applied R&D from other sources.[20] By comparison, nationally, industry invested $6.8 billion in R&D and conducted $9.1 billion, a leverage of 26%. There is substantial support available from federal innovation programs, however industry in Atlantic Canada is unable to leverage it at a level proportional with industry elsewhere in the country. This is in part a function of industry structure in the region, with few large firms and a relatively low level of applied industry R&D, and it may also be due to distance from Ottawa impeding access to some national programs. (Leveraging investments is discussed more in Section 4).

Currently Atlantic Canada's R&D capital asset base (human and physical infrastructure) resides in universities and government laboratories that conduct $423 million (or 82%) of the total $518 million Atlantic R&D. Research and development undertaken by industry in the region is reported to be only $95 million. While industry must strengthen its R&D capacity, in the short term, the region should leverage the significant (pre-paid) assets of university and government facilities to the fullest. Strong relationships, as well as representation and involvement among the region's universities and granting councils is extremely important to continue to build this asset base for the combined university/industry Atlantic economic community.

Leverage intellectual & physical infrastructure at universities to expand industry-related R&D and innovation activity.

Increased industry-related applied R&D at universities will require policies and programs to:

i) Increase **understanding and awareness** of the need for university/ industry relationships.
ii) Provide **incentives, benefits and rewards** for industry/university partnerships and innovation initiatives.
iii) Strengthen the **university/industry liaison service** function.
iv) Employ **co-op students, graduate and graduating students** on industry projects to help retain them and build future industry leaders.
v) Facilitate opportunities for more **professors to serve as advisors, researchers** and in **chair positions** in applied research and knowledge transfer processes.

The commercialization objective within the Atlantic Innovation Fund (AIF) is intended to assist these policies. Emphasis on industry-related applied R&D does not imply that the region does not need to increase basic R&D capacity. However, the balance must weigh heavily towards applied and industry driven R&D if Atlantic Canada is to build a much stronger innovation based economy in the upcoming years.

University/industry liaison and knowledge dissemination programs typically generate direct financial returns of only 1–2% of total research expenditures. Yet, they are an

[20] Statistics Canada, Science Statistics, Catalogue 88-001-X1B/ISSN 1209-1278, Vol. 24, No.6 and No.7.

important university service that should not attempt to be financially self-sufficient. There is presently the prospect of the federal government making this a social investment tied to research grants in the order of 5% of the R&D base.[21] This level of effort is sufficient for mature systems but it is inadequate for Atlantic Canada with only 3.5% of the NSERC research budget (approximately $100 million) for all 17 universities and colleges – if it materializes.

The Atlantic region's research community is too widely dispersed to provide commercialization capability in all settings, but it must have awareness, liaison and network presence everywhere. This requires knowledgeable staff, with a good understanding of industry requirements, to effectively facilitate university/industry innovation partnerships. It also requires appropriate programs to attract industry and support these partnerships. Atlantic Canada universities seem to struggle with this issue.

Increase investment in university/industry liaison programs to improve skills & services, and expand staff & programs. Establish a network of a few key liaison offices, each partnering with several institutes to better serve the region.

While the scale of investment may be larger, the strategic approach by the Massachusetts Institute of Technology (M.I.T.) Lincoln Laboratory, and Whitehead Institute research facilities demonstrate successful alliances between business and research institutes. Each year, more than $750 million in *sponsored* research is conducted on campus at M.I.T. at these facilities. This research generates about 400 new inventions per year,[22] which are marketed through the Technology Licensing Office at M.I.T. The core of this office is a group of technically trained and business oriented people who work with industry, venture capitalists and entrepreneurs to commercialize new technologies and software.

In another part of the U.S., Ohio State's Office for Technology Partnerships was established in 1998 to implement best practices in technology partnerships.[23] TechPartners includes seven university and non-university organizations aligned to achieve the university's goal of attracting top faculty and attracting bright students. It is their belief that this can be achieved by providing students with opportunities to apply their classroom learning with industry partners, and by providing faculty with opportunities to do top quality research and see it commercialized. TechPartners works with mature businesses, assists with start-ups, and guides both students and faculty in building relationships with these firms.

[21] ACST report and Federal White Paper: Public Investments in University Research: Reaping the Benefits. Report of the Expert Panel on the Commercialization of University Research Presented to: The Prime Minister's Advisory Council on Science and Technology, May 4, 1999.
[22] M.I.T. Technology Licensing Office (TLO), http://web.mit.edu/tlo/www/, October 2001.
[23] Ohio State University TechPartners (copyright 2000), Technology Licensing Office website http://www.techtransfer.rf.ohio-state.edu/, October 2001.

With a small population base and a limited number of researchers to bring the necessary talent to attract both academic talent and industry investment, institutes in Atlantic Canada may consider building alliances with *brain power* from outside the region. The IC^2 Institute – a multi-disciplinary research and education institute at The University of Texas at Austin – links technology, entrepreneurship and education through their unique IC^2 Fellows Program. For the past 23 years, honorary positions have been bestowed upon "like-minded innovators…whose interests and experiences parallel the mission of the IC^2 Institute."[24] There are more than 200 IC^2 Fellows worldwide, bringing together (physically and virtually) some of the world's finest minds including Nobel Laureates and Medal of Technology winners. IC^2 Fellows are selected from academia, government, business, the media, and the non-profit sector and, while they bring great knowledge and international acclaim to the Institute, the Fellows collect no stipend. Participants are attracted by the opportunity to collaborate in this rich *brain trust*. "As the Institute's most valued "Share Tank," the Fellows Program has the capacity for unparalleled growth."[25]

At present, Memorial University of Newfoundland hosts Atlantic Canada's only Network of Centres of Excellence (NCE). In 2000, Industry Canada and Canada's three Granting Councils announced investment of $14.4 million over four years for the AquaNet NCE. The goal is to secure the Canadian aquaculture industry's future by increasing the efficiency of aquaculture production through species diversification, biotechnology, and training of highly qualified personnel, while addressing environmental and social impacts. AquaNet includes 73 researchers from British Columbia, Ontario, Quebec and all four Atlantic Provinces as well as foreign researchers. It involves 16 universities, 34 industries, 23 agencies and others. It is a prime example, as is Genome Atlantic, of strong national and international university/industry alliance capabilities that may be centred in the region.

3.4 Capacity Building

In strong KBE (knowledge-based enterprise) economies, relative percentages of R&D performer capacity approximate the following: Industry 60 to 75%, university 15 to 25%, and governments 12 to 15%. Thus, in terms of expenditures, industry is performing three to four times more R&D than that of universities, and two or more times that of universities and government combined.

In comparison, relative percentages in the Atlantic region (in 1998) were almost the reverse of those of strong KBE economies.[26] A comparison between 1998 (overall) Canadian and Atlantic Canadian R&D performer levels and ratios of investments is summarized in the following table.

[24] IC^2 @ The University of Texas at Austin, website http://www.ic2.org/, October 2001.
[25] IC^2 @ The University of Texas at Austin, website http://www.ic2.org/, October 2001.
[26] Statistics Canada, Science Statistics, Catalogue 88-001-X1B/ISSN 1209-1278, Vol. 24, No.6 and No.7.

Gross Expenditures in R&D ($million) 1998

Performers $	Canada $	% within Canada	Atl Can Total $	% within Canada	% within At. Canada
Fed Gov	$ 1,729	11.4%	$ 143	8.3%	27.6%
Prov Gov	$ 216	1.4%	$ 14	6.5%	2.7%
Business	$ 9,111	59.9%	$ 95	1.0%	18.3%
High Ed/Univ	$ 3,963	26.1%	$ 266	6.7%	51.4%
Non-profit	$ 182	1.2%		0.0%	
Total	$ 15,201		$ 518	3.4%	

Table 1: 1998 R&D Performer Levels

While Federal, provincial and university R&D activity is appropriate to the region's population base, the lack of critical mass of industry R&D activity throughout Atlantic Canada is by far the greatest disparity with the rest of Canada. It must rise from 1% to 7.7% (of the total amount of R&D performed in Canada), while university capacity should also increase $44 million (or an additional $1/6^{th}$ of the current level of $266 million) in order to equal the national average as adjusted to the region's percentage of the Canadian population, as below.

Gross Exp. R&D ($million) 1998 Adjusted to attain Cdn average per population base

Performers $	Canada $	Atl Can Total	Atl Can Total $	% within Canada	% within At. Canada
Fed Gov	$ 1,729	10.9%	$ 143	8.3%	11.8%
Prov Gov	$ 216	1.4%	$ 14	6.5%	1.2%
Business	$ 9,766	61.4%	$ 750	7.7%	61.6%
High Ed/Univ	$ 4,007	25.2%	$ 310	7.7%	25.5%
Non-profit	$ 182	1.1%		0.0%	
Total	$ 15,900		$ 1,217	7.7%	

Table 2: Recommended Adjustments to R&D Performance Levels

To approach the higher US industry applied R&D/university R&D ratio of 4:1, and an even more innovative economy, industry capacity would need to be adjusted upward in the order of $1.1 billion. This would raise Atlantic R&D to 10% on a national per capita basis. Interestingly, all of the other capacities would not need adjustment to mirror the US levels if this industry capacity adjustment were made.

Increase R&D performer capacity of industry.

In addition to increases in R&D performer capacity, regions of strong KBE economic development also have high industry *receptor* capacity for university research outputs. As there are a few companies in the Atlantic region conducting applied R&D, this is an area requiring significant focus for development.

> *In a province such as New Brunswick, not many companies have R&D capacity and the majority of them are not aware of research done in universities and the potential for commercialization of such research. As a*

result, many companies are not ready to invest in commercial ventures with researchers and research institutions.[27]

In order for industry to be the recipient of the successful transfer of knowledge/ technology from universities or other research institutes, they must have an R&D capability equal to, or greater than, the provider (i.e. university).[28] Industry must be able to conduct additional applied R&D, prototype development and develop commercial applications and then be prepared to undertake additional R&D to render obsolete their own products before competitors do. This is presently not the case in Atlantic Canada. Implementation of mechanisms in the universities and research institutes for attracting and retaining quality research expertise, rigorously evaluating the commercial potential of research results in concert with industry and "providing incentives for linking with industry and engaging in prototyping" may help to shift the focus and make up for gaps in industry performer R&D.[29]

Increase R&D receptor capacity of industry in Atlantic Canada.

"There should be attention to encouraging universities to undertake directed industry research and to implement outreach programs to companies seeking to improve their products and services or improve productivity in business processes."[30] The benefits include students who are both more knowledgeable and better trained as well as better prepared to participate in the workforce, retention of graduate students and professors to support longer-term industry relationships in the region, and industry support for funding to universities.[31] This will help industry leverage their R&D dollars while building regional capacity for innovation and commercialization. Students may stay in the region providing industry with excellent, well-trained employees and management, and the number of highly qualified people (HQP) in the region will grow to fit the economic development activity in the knowledge-based sector.

In addition to promoting industry and university collaboration in innovation, and providing incentives for industry-driven applied R&D, several survey respondents suggested assisting students in business start-ups or entrepreneurial activity. The Washington Research Foundation (WRF) established a seed venture fund called WRF Capital to support students and academics in innovation and commercialization activities. "Our goal is to foster creative thinking, research and scholarship at the University of Washington, and in so doing, to stimulate the growth of start-up ventures based on research done at the university."[32] Over the past 20 years WRF has donated nearly $100 million to the University of Washington.

WRF Capital invests in local private technology companies and uses the gains to support research and entrepreneurship at Washington State research institutions. Additionally, the

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[27] Interview and commentary from survey respondent/stakeholder in New Brunswick, August 16, 2001.
[28] Dr. John Mcdonald, Mcdonald, Detwiler and Associates personal communication and Dr. A. Cornford, 1986.
[29] Survey respondent and e-mail commentary, July 6, 2001.
[30] Survey respondent and e-mail commentary, July 6, 2001.
[31] Survey respondent and e-mail commentary, July 6, 2001.
[32] Howell, Ron, President of WRF Capital, http://www.wrfseattle.org/, October 2001.

Foundation leases office space to technology-based start-ups through the WRF Venture Center. The WRF Venture Center offers entrepreneurs short-term, flexible office facilities and business support including expert assistance with intellectual property management (creation, protection, and transfer). "In some ways, we are like other venture capital firms, but we sometimes are willing to tolerate more risk".[33]

The University of Washington (UW), Simon Fraser University (SFU) and The University of Toronto Innovations Foundation all host business plan competitions. UW's program is sponsored by the Center for Technology Entrepreneurship at the School of Business Administration, the name of which implies the focus on supporting student entrepreneurs.

SFU's initiative is a province-wide business plan competition sponsored by New Ventures BC, and involving SFU business school professors who join a panel of local business executives in vetting the submissions. The winning business plan receives $50,000 in funding for start-up. SFU's industry liaison office also hosts monthly "angel forums" in which local start-ups can present their business plans and receive valuable critiques of both their fundraising presentation skills and of the ventures. The angel investors are drawn from successful local business executives and independent investors who may be willing to finance next stages in the companies' development. Many of the new ventures are start-ups borne from innovations derived from medical, biotechnology and telecommunications applied R&D at B.C.'s universities.

3.5 A Culture of Innovation and Commercialization

The above perspectives pertaining to structural and economic issues are important to the facilitation of increases in innovation and commercialization. However, the cultural and social *will* to effect necessary change is even more critical to success. There is no simple way to quantify this; it is of the highest importance and it is essential for success.

> *Innovation in all our industries is the key to expansion and growth of our economy. Our universities and research institutions provide a potential advantage, but innovation means much more than research. It is also about increased commercialization of new ideas and processes. In a small economy... the quick adoption of new technology and good design practices is as important as research and inventions; it leads to many innovative products and processes. We must mobilize government, the private sector, and our academic institutions... to create* ***a culture of innovation*** *and design. We also need to build on such initiatives as those carried out by our universities and private sector aimed at commercializing more of their research and development. These activities together make up our innovation system, and international evidence shows the best strategy is to assure that the whole innovation system is working, not just fragments of it. Our future economic growth... will depend on our overall innovative performance.*[34]

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[33] Howell, Ron, http://www.wrfseattle.org/, October 2001.

[34] R&D /Innovation Strategy, Province of New Brunswick Total Development Fund: R&D/Innovation Strategy Department of Business New Brunswick, June 28, 2001.

Create a culture of innovation in universities and the private sector.

Creating a culture of innovation remains an important challenge to Atlantic Canada, as was expressed by several stakeholders and survey respondents from the region. "There are two great impediments to commercialization. The first is, quite simply, institutional cultures and management attitudes within publicly funded organizations." [35] "We need drivers...that know when to take risk...and when to stop."[36] "The second impediment is industrial attitudes... Not enough investment in people, not enough investment in market expansion, risk aversion... conservative business practices...and unwillingness to look beyond the region for benchmarks."[37]

> *In the Atlantic Provinces, we have ACOA that provides good capital funds for innovation. We have NRC with the IRAP program that covers some R&D projects. We have good researchers. We have excellent provincial programs for start-up. We even have access to other funds if the projects are excellent. The problem is the human factor involved.*[38]

The same stakeholder cited the bureaucracy and impediments associated with the time to manage projects. "When you deal with industries time is important. Time to make a decision, time for the government to reimburse... time to market..." time wasted on processing contracts, on preparing documents and excessive paperwork.[39] He cited the need for "drivers closer to the real people", armed with the "tools and flexibility to organize" prospects, people and projects.[40] Similarly, a strategic planning initiative at Johns Hopkins University Applied Physics lab indicated that empowerment of the technology transfer process was among the key requirements for success, as well as market pull and management of conflict.[41] The drivers must have both the knowledge and the power to respond quickly and efficiently to industry's needs and market demands. We need to have them at different locations in the government agencies but especially in the Universities where the technology is being used and invented.[42]

Intellectual Property (IP) policies at universities and other research institutes are also important attractants or deterrents to industry partnerships. Opportunities for control of IP via licensing and royalty agreements are often perceived by researchers as an incentive to undertake research and development. However, the opportunity for ownership and control of IP may be less important to university researchers if they have other incentives. Examples of incentives include: long-term and repeat contracts for industry research; support for students; additional fees for researchers paid via industry or government

[35] Survey respondent and e-mail commentary, July 6, 2001.
[36] E-mail commentary/correspondence, August 20, 2001.
[37] Survey respondent and email commentary, July 6, 2001.
[38] E-mail commentary/correspondence, August 20,2001.
[39] E-mail commentary/correspondence, August 20,2001.
[40] E-mail commentary/correspondence, August 20,2001.
[41] The Saint Johns Hopkins Applied Physics Laboratory (APL) website http://www.jhuapl.edu/ott, October 2001.
[42] Email commentary/correspondence, August 20, 2001.

funding; positions as advisors, staff, consultants or as Board members; funding and in-kind contributions to university laboratories and research facilities.

Universities that attract deal flow through large numbers of industry research contracts and long-term industry relationships, derive more benefits to universities, researchers and society than those with policies that focus on aggressive IP licenses and royalties. Innovation benefits are realized if the IP remains in industry within the local economy. At M.I.T.'s Lincoln Laboratory, and at the Whitehead Institute, in the past five years, there have been over 100 U.S. patents issued per year with 60 to100 option and license agreements signed. Most of these licenses are exclusive.[43] Under these licenses, companies are granted rights to M.I.T.'s patents in return for their commitment to develop the inventions into products.

Eliminate IP barriers to industry investment in university R&D and research outcomes. Create incentives for university researchers to pursue long-term industry relationships.

The Atlantic region has a declining population base and the region only attracts a small number of immigrants with skills in the knowledge-based industries. Retention has also been a challenge, and a significant percent of university graduates leave the region. A further challenge results from limited number of incentives for many residents to work in productive jobs. People with the expertise and the *will* to drive a knowledge-based economy are critical to success. These intellectual assets must not be lost; they must be retained, motivated, nurtured and expanded.

Sustainable investments must replace traditional incentives. Low and predictable corporate and employee tax regimes must provide incentives for knowledge-based employees and encourage more research and development. Clusters of excellence that weld together university and industry assets are needed to produce long-term growth. Yet the true core of any successful cluster is cooperative collaboration among intelligent people --both research and business people. Success in clusters is not driven by technology -- but by people -- continuously innovating (both in research and in business strategy) to commercialize knowledge and technology in a dynamic, ever-changing marketplace.

Perhaps Jack Welch, CEO of General Electric (GE) sums it up best: "...You need the best players to win the game..." [44] Welch believes that GE's core competency is people-building teams and developing leaders. He stresses the advantage of diversity in the knowledge and skills of its leaders. "We believe the company's ultimate competitive edge is the ability to learn and thirst for knowledge,"[45] he said. At quarterly meetings, GE

[43] M.I.T. Technology Licensing Office (TLO), http://web.mit.edu/tlo/www/, October 2001.
[44] Welsh, Jack as quoted in UCLA EMBA article "Welch Offers Insights, Inspiration -- Management Guru Tells It 'Straight from the Gut'" Association of University Technology Managers (AUTM): http://www.autm.net/index_ie.html and http://patron.ucop.edu/ncd/ncd.html, October 2001.
[45] Welsh, Jack as quoted in UCLA EMBA article "Welch Offers Insights, Inspiration -- Management Guru Tells It 'Straight from the Gut'" Association of University Technology Managers (AUTM): http://www.autm.net/index_ie.html and http://patron.ucop.edu/ncd/ncd.html, October 2001.

brings together the leaders of all of its businesses to offer generic best practice ideas. Developing and implementing *best practices* for a more robust climate of innovation and commercialization in Atlantic Canada will require a similar approach. A culture of innovation requires both the cooperation and the collective will to take risks and effect change. It cannot exist without leaders and innovators. "Universities have the heavy responsibility of producing the most crucial element of R&D: highly qualified people, or simply HQP."[46] This will require programs to train entrepreneurs, initiatives to create opportunities for researchers and business people to network and forge partnerships, and investment in cultural change to foster a climate conducive to innovative economic development. Survey respondents suggested introduction and expansion of internship programs, business mentorship and development of "a network of business experts that provides 'hands-on' assistance to start-ups and...collaborates with a specialized business support team."[47] By investing in people, the region will expand both its performer and its receptor capacity.

Invest in people. Design programs & incentives to attract business people and researchers to drive innovation, entrepreneurial activity and commercialization in Atlantic Canada.

Among the initiatives already in place to help create an environment and culture of innovation associated with universities in parts of Atlantic Canada is the Entrepreneurship Endowment. Established by the faculty of Computing Science at Dalhousie University, the Endowment provides funding to students for business-oriented activities, encourages students to form companies and, if GINI deems their venture to have economic potential, the students may become clients of GINI's new venture incubation facility. In addition to encouraging teamwork, creativity, entrepreneurial activity and an orientation to business, GINI has introduced networking and industry mentoring opportunities and a course in entrepreneurship. As clients of GINI, the start-ups may also access seed funding from partners in Nova Scotia and Ontario.

"...Innovations are a function of the quality and constructiveness of relationships within its communities, based on an overall common vision."[48] Federal government recognition of the need for sustained *social* investment in the commercialization of university research results is a very positive step. Provincial recognition is strong in some provinces and lacking in others. Common recognition is the first step, partnerships and collaborative initiatives are an important next step requiring the support of the provincial and federal programs that help facilitate this cultural change. A collective will and a common understanding of the goals of innovation and commercialization are the foundation of a successful transition to a more innovative economy in Atlantic Canada.

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[46] Nicholson, Patricia quoting Claudine Simson, Vice-President Nortel Networks Corp. at the Research Money conference (November 13, 2001), *Government wants Canadian R&D in Global Top Five*, http://www.itbusiness.ca (archives).

[47] Survey respondent commentary, October 4, 2001.

[48] An Innovative Society and the Role of Government, Report of the Auditor General of Canada to the House of Commons, 1994, Chapter 5, page 9.

You can buy almost everything today. You can buy ideas, you can buy knowledge, you can buy materials and resources; you can even buy the use of money. The only thing you cannot buy is the courage and the persistence to implement creative ideas.[49]

[49] Wolfgang Fürniss, "Some Thoughts on Definitions of Innovation", by the Editorial Board of *The Innovation Journal* http://www.innovation.cc/discussion_papers/thoughts_innovation.htm, October 2001.

Section 4: Funding Innovation & Commercialization

All stages of innovation and commercialization activity in Atlantic Canada require additional capacity and investment. Finding adequate sources of funding is always a challenge, but perhaps the greater challenge is to target funding to key areas of strength with the best opportunity to stimulate sustainable economic development in Atlantic Canada. A further challenge is to balance funding throughout the stages in the innovation and commercialization process in order to optimize results and to foster a level of activity that is both efficient and effective.

4.1 The Atlantic Innovation Fund

In the Speech from the Throne (2001), the Canadian government addressed the importance of improving Canada's R&D performance in order to foster a more innovative economy for this nation. In addition to increasing research and development, the federal government's innovation agenda is based on developing a highly skilled work force and a positive business climate. Among the goals set forth in the speech, is the improvement of Canada's R&D performance to among the top five countries from its current 15th place ranking by 2010. To accomplish this, the government is committed to doubling federal expenditures on R&D. The government also implicitly recognizes the role to be played by the private sector, as the nation's largest research investor, in achieving this objective.

The Speech from the Throne specified the following actions:

- Strengthen the research capacity of universities and government labs and institutions.
- Accelerate the commercialization of research discoveries.
- Pursue a global strategy for Canadian science and technology through collaborative international research.

In Atlantic Canada, the federal government launched its Atlantic Investment Partnership, including an Innovation Partnership infusion of $410 million over 5 years to the region's innovation system. Through the strategy, the government is investing $110 million in the National Research Council's regional research capacity, and $300 million in the Atlantic Innovation Fund to facilitate projects which address the commercialization objective as well as research capacity gaps and opportunities. The design of the AIF also took into consideration issues related to private sector R&D and receptor capacities, industry-university liaison/alliances, established research strengths, and attraction/retention of high calibre researchers. The Partnership is also designed to help improve regional response to the government's main national innovation programming.

The response to the first round of the AIF has been quite remarkable: 195 proposals were submitted from across the region seeking a total of $810 million toward total project costs of $1.5 billion.[50] This speaks positively to the calibre of those projects that will succeed

[50] The Honourable Robert G. Thibault, Minister of State for the Atlantic Canada Opportunities Agency (ACOA) quoted in October 26, 2001 Press Release: *Atlantic Innovation Fund Generates $1.5 Billion In Proposals*, Moncton, New Brunswick.

in obtaining AIF support, but it will also result in the majority of proposals being rejected.

Clearly, the government's innovation investments in Atlantic Canada are making a vital contribution to the region's innovation capacity. However, there is a fundamental structural difference in Atlantic Canada's economy from the rest of the country, and that lies in the region's private sector. The government's national strategy rightly acknowledges the key role that the nation's private sector must play in achieving its primary innovation objective. The region's post-secondary and public sector research institutions will have to continue to carry a disproportionate share of Atlantic Canada's R&D until such time as private sector capacities move toward national rates. The AIF represents an important beginning, however, new federal investments will be needed to address this issue. To sustain a focus on increasing university and public sector R&D capacity when the private sector lacks the capacity to receive the emerging technologies will limit the contribution Atlantic Canada can make to achievement of the government's R&D objective.

4.2 Leveraging Investments

The Atlantic region falls short of the national average (or even the per capita average) for federal funding that matches or leverages R&D, innovation and commercialization investments in the region. Whether this is a result of lack of critical mass, lack of proximity, lack of matching provincial contributions, lack of awareness of the opportunities for funding, or other factors, is uncertain and requires further investigation.

Of more than 50 applicable programs reviewed that support the national innovation agenda, many of the programs are not presently being exercised to their fullest extent to support Atlantic Canada. Industry in this region invests $89 million in R&D and conducts $95 million. This is $6 million (6%) more than it invests. Leverage ratios for many national programs are in the 3 to 6% range.[51] A notable anomaly is NRC/IRAP, which is local (thus, perhaps supporting the proximity theory). Atlantic Canada's uptake of IRAP is at 13.8% of total IRAP funding (almost 2 times the national per capita average). This is an indication of local leverage capability.

R&D $(000,000)	Canada		Atlantic Canada	
Industry R&D Investment	$ 6.8		$ 0.89	
Industry Performed R&D	$ 9.1		$ 0.95	
R&D funding Leverage	$ 2.3	26%	$ 0.06	6%
NRC/IRAP funding leverage				13.8%

Table 3: Leverage of Industry Investment

[51] APEC paper for the IC Roundtable, Halifax, NS, October 4, 2001.

Canadian industry invests $6.8 billion and conducts $9.1 billion in R&D, which is $2.3 billion or 26% more than it invests. If industry in Atlantic Canada were to operate at the Canadian average it would gain $20 million per year more on the $89 million industry invests in R&D.

Atlantic Canada has approximately 7.7% of the Canadian population. Using the percent of population as a basis for determining an appropriate proportion of Canadian industrial R&D, Atlantic Canadian industry would have to perform an additional $665 million annually to be at the Canadian average. If Atlantic Canada were to approach the Canadian per capita of 7.7% of industry R&D this would require an additional investment approximating $665 million annually. The 26% leverage factor on this amount would equate to $170 million annually. In the short term, it is unrealistic to contemplate this level of R&D or attainment of the Canadian average of 26%. However, it may not be unrealistic to make a transition towards the NRC-IRAP matching ratio of 13.8% on some proportion of this amount. The funding exists today and, under favourable policies, could be targeted for Atlantic Canada at no detriment (but amid more aggressive internal competition) nationally.

Access matched funding & other federal funding sources for innovation programs to increase leveraged capital.

In addition to garnering matched funding, in other provinces industry leverages its financial investment in R&D by accessing federal and provincial tax rebates and taxation policies that support innovation and commercialization. While this may appear to be a loss to provincial government coffers, the return on this investment should outweigh the short-term tax losses with longer-term economic development in the region.

Modify corporate and employee taxes to provide incentives for innovation & commercialization, and to attract & retain skilled researchers and entrepreneurs.

4.3 Targeting Funding

Review of best practices in other regions indicates that 5% or more of the public R&D investment should relate to university/industry relationships and dissemination of research outcomes to industry. Without this investment in dissemination, the public R&D benefit may never be fully realized in society or contribute to economic development.

Ideally, however, the major R&D investment impetus for highly innovative economies comes from industry or industry-focused agencies. Most effective applied research alliances direct their investment efforts in the following apportionment:

(a) Strong applied research relationships and networks – 20%,
(b) University professor and student fellowships – 10%,
(c) Applied research – 20%,
(d) SME mentoring, pre-seed and seed investment – 50%.

Recommendations on changes required in Atlantic Canada from some of the region's questionnaire respondents included the need to enhance the region's "ability to attract public and private investment/partners"[52] and establish such partnerships with a strong "commercial market focus."[53]

At the Evanston campus of Northwestern University, industry/university partnership in establishing a seed capital fund for early-stage equity financing has reaped excellent returns. The Evanston Business Investment Corporation (EBIC) directed the funding to companies located in Evanston (or the nearby Chicago metropolitan area) or growth oriented companies affiliated with the university. The first fund of US$1 million was organized in 1985 as a non-profit seed fund to create new jobs and broaden the economic base of Evanston. Investors in that fund included First Illinois Bank and Trust, State National Bank, American Hospital Supply Corporation, an insurance company and the university.

EBIC invested in 23 start-up companies between 1986 and 1992, all located in Evanston, Illinois. The total returns from EBIC's first fund exceeded US$2 million. In 1993, EBIC organized its second fund, Evanston-Northwestern University Investment Partners, L.P. (E-NUIP), which raised about US$1.5 million in total capital from additional bank and corporate partners. The goals are to earn an above average return on investment for the limited partners, while achieving the regional economic development and job creation objectives outlined above.

In Atlantic Canada, TARA has produced similar results and successes in little more than 6 years with similar levels of investments. A five-year review of the TARA program has been undertaken by ACOA. This early success must continue to be supported and expanded. There are numerous other economic development and social assistance investments regionally and provincially in Atlantic Canada that influence innovation and the KBE activity in the economy – but their contribution is not easily accorded just to innovation. We have identified several of these sources of investment, but without further detailed assessment, can only provide hints where they may be of significant assistance to the strategy. It is suspected that a portion of the large annual social and economic investments made in Atlantic Canada programs — both federal and provincial — can effectively contribute to development of innovation economic capacity. This bears closer review and scrutiny as a strategic model and plan are formulated.

Review allocation of social and economic funding to identify opportunities to fund innovation and commercialization programs within an integrated strategy

[52] Alan Cornford e-mail correspondence with Atlantic region survey respondent, August 14, 2001.
[53] Alan Cornford e-mail correspondence with Atlantic region survey respondent, August 14, 2001.

4.4 Distribution of Funding and Return on Investment

Despite the potential for accessing additional financial resources, there are many innovation and commercialization programs and ventures competing for limited funds. If too many projects receive funding, allocation is spread too thinly and few projects or agencies receive adequate financial support to foster significant economic development in the region. Just as a few pinnacles of strength must become the focus of innovation and commercialization activity, so too must funding be focused to invest in these targeted areas of strength.

Target funding to a few pinnacles of strength.

Selection of the few pinnacles should not be based solely on innovative projects or commercial sectors with potential. Distribution of funding and investment must take in to consideration the leadership and innovative talent required for success. Jack Welch, who boosted General Electric's market capitalization by more than $450 billion during his 20-year tenure as CEO, believes the corporation's pinnacles of strength were built around its teams of high calibre employees. He maintains that differentiation is critical to an organization's success, and to "to do that, it's essential to differentiate employees by fielding the best team and getting the best talent."[54] Welch used a grading system for ranking his employees and stresses that "one of the great challenges of an organization is to make sure that your best know they are your best."[55] Similarly, Atlantic Canada will benefit by differentiating itself with a few pinnacles of strength, and by attracting and supporting excellent leadership and talent with the skills to support a more innovative economy.

For success, the innovation and commercialization process must be integrated, such that applied R&D is driven largely by commercial *pull* from industry in targeted areas of focus. This will enable development to be more efficient and effective, thereby enabling a *critical mass* capability to emerge in certain sectors. Nevertheless, relative capacity among and within in each stage will vary, and with many different stakeholders, the challenge will be to overcome different and competing objectives.

All stages in the innovation and commercialization process in Atlantic Canada require additional investment and capacity building. Without critical mass, the amount spent on overhead and infrastructure is not economically justifiable. Questions remain about appropriate absolute levels (in the region and in the provinces), balance of capacity among the stages, and how to secure sufficient investment. The challenge is to implement the strategy appropriately to achieve optimum results, at each stage, with limited resources.

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[54] Welsh, Jack as quoted in UCLA EMBA article "Welch Offers Insights, Inspiration -- Management Guru Tells It 'Straight from the Gut'" Association of University Technology Managers (AUTM): http://www.autm.net/index_ie.html and http://patron.ucop.edu/ncd/ncd.html, October 2001.
[55] Welsh, Jack as quoted in UCLA EMBA article, October 2001.

Establish a critical mass to improve efficiency and efficacy by increasing funding and activity at each stage in the innovation and commercialization process.

There are a few examples of agencies – notably Genieo and TARA in Atlantic Canada and British Columbia's BC Advanced Systems Institute (BCASI), that have produced successful economic outcomes reported in 5-year, 10-year and 15-year independent reviews. The ratios of balance of focus in these agencies provide some guidance and, in the case of TARA and Genieo, these are 'made in Atlantic Canada' initiatives that are operating within the Atlantic regional culture and economy.

Allocation of investment and focus of BCASI, TARA and Genieo:

Awareness & Networking	**Univ. Research Fellows/ Student Awards**	**Applied Research Programs**	**Germination Investment**
20 %	10-20%	20%	40 -50%

If the *applied research* and *germination* investment programs are combined (primarily associated with industry R&D and receptor capacity), these ratios approximating 60 - 70% industry and 20% university, show consistency with the ratios and pattern indicated in earlier sections for U.S. and Canadian averages for innovative economies.

These programs are also industry driven, utilizing industry/university partnerships and joint expertise, and capitalizing on mentorship provided by regional industry leaders.

Determine the appropriate balance of funding for each of the stages in the innovation & commercialization process.

Section 5: Innovation and Commercialization Summary Diagnostics

The diagnostics in this review suggest the feasibility of making significant progress in the transition to a culture of innovation and commercialization by building on current strengths. However, a few significant, focused and sustained investments are required in strong industry/university partnerships, and in the people to drive this agenda.

5.1 Best Practices in Knowledge/Technology Transfer

The following are some of the guidelines or *best practices* observed in various regions undertaking innovation and commercialization in association with academic and research institutes.

Return on Investment -- Leverage Opportunity or Responsibility

- Knowledge transfer is a fundamental element of the educational mandate.
- Research support requires building strong relationships with industry.
- The existing taxpayer investment may be further leveraged via knowledge dissemination -- whether or not there is direct or incremental financial return on investment to stakeholders.

The Importance of Building Community and Facilitating Relationships -- Client Accessible, Client-Driven, and Client Responsive

- Universities benefit from developing and maintaining access to, and interaction with industries' knowledge base.
- Bridging university/society/industry cultures is an essential aspect of the knowledge transfer process.
- The process is better facilitated if innovations are *pulled* by the client rather than *pushed* by the university.
- University licenses can build local community through use restrictions.
- "The usefulness to society of any research is proportional to the interactions between the generators of the technology (university) and the adopters of the technology (industry)."[56]

Leverage from Relationships

- Lessons learned from other jurisdictions: "It seems clear that when the government teams up with academia and industry, and participates throughout the spectrum of technology, the U.S. becomes dominant in that industry. However, when we fail to fund the gap, other countries will, often leading to foreign commercialization of our technologies."[57]

[56] Alan Preston, Technology Transfer Office Literature, MIT.
[57] Alan Preston, Technology Transfer Office Literature, MIT.

People, People, People ... and then Technology

- Brilliant people (much more than technology) working cooperatively in a solid relationship will more often result in lasting success.
- Incentives or reward systems for researchers (from university and funding agencies) and for intellectual property management, and systems that build trust and liaison education are very important to facilitating aggressive innovation and knowledge transfer.
- "The recipient must have a capability equal to or greater than the provider (of the knowledge/technology)."[58]
- You can pick winner people but you can't pick winner technologies.
- The process requires building relationships and trust, and that takes time and familiarity.
- The major criterion is not the economic value, but potential for a valuable relationship that will facilitate success.

The Functionality and Profitability of the Knowledge/Technology Transfer Process

- Good university technology transfer agencies usually generate only about 1% (for small institutions) to 3% (for the very large institutions) of the value of the research budget annually when mature.
- Unusually high returns for particular relationships have been the result when very high success in innovation and commercialization has been achieved (e.g. MIT and Stanford after 30 years, such as with Cohen/Boyer DNA development).
- The process does not typically result in direct returns on investment --but it facilitates dissemination via a broker process.
- The investment community treats it as such, and not as a direct profit centre.
- In the formative years (7-10) knowledge/technology transfer is not a self-sufficient function – but requires investment of 3 to 5% of the investment as part of the creation/dissemination mandate.[59]
- It is a cost centre rather than a revenue centre – but it is essential.
- The emphasis each university will place on the service function for dissemination is presently an individual university decision (and often at the expense of strained research and/or administration budgets).
- The results of this emphasis will often be reflected in the success rates for the knowledge transfer process (and the support for innovation by researchers).

Profitability Margins in the Complete Commercialization Process

- Venture capital companies attribute 70% of their investment to people, 25% to markets, and 5% to technology.
- Much of the risk and rewards lie in the marketplace and not the transfer process.

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[58] Alan Preston, Technology Transfer Office Literature, MIT.

[59] Recognized by the ACST panel review – recommending 5% of R&D budget – likely to be a part of the *White Paper on Innovation* and next federal budget. *Public Investments in University Research: Reaping the Benefits*, Report of the Expert Panel on the Commercialization of University Research Presented to: The Prime Minister's Advisory Council on Science and Technology, May 4, 1999.

- Venture companies look for ventures with potential value of $80 -$100 million, 10-times return on investment (ROI) and 20% to 40% of company equity in the first round of financing.

Balancing Revenue, Relationships and Rewards

- Unrealistic expectations, protracted negotiations, or other delays create barriers to deals with industry.
- If trust and empathy between the inventor(s), the transfer agent and industry is solid, there is neither benefit nor hindrance from different university IP policies (ACST is recommending university ownership if there is adequate dissemination funding and reporting to the research fund provider).[60]
- A small royalty or equity position in a successful venture is better than a larger position in a relationship that fails.
- Openness, access and positive industry relationships are more important to university success than size.

5.2 Summary Diagnostic Observations

The following section summarizes the key points raised in our analysis. These should be central to further dialogue and to the development of a strategic framework for increasing the level of innovation and commercialization activity in Atlantic Canada.

- The innovation and commercialization process requires a critical mass of investment (capability and infrastructure) in each element of the process as well as integration throughout the process. There are deficiencies in the process in the Atlantic region (and in each of the provinces) that require sustained social investment.

- Innovative economies have R&D ratios weighted towards industry (applied) R&D at least in the order of 2:1 (and as high as 4:1) with respect to publicly performed university R&D. A reasonable target is 60% industry performed R&D and 30% public performed R&D. The Atlantic Canada ratio presently is the reverse –18% industry and 51% university or 1:2.8.
    (a) The Atlantic economy does not have an innovative profile;
    (b) It does not have the breadth and depth of receptor capacity to absorb and commercialize the results of existing or increased university R&D.

- Existing public federal innovation-related investment models do not properly recognize several needed sustained social investment partnerships. More innovative federal structures and public investment models are required.

- ACOA, WD, IC and other federal economic development agencies lack sustained social investment instruments to support initiatives that will not and should not

[60] *Public Investments in University Research: Reaping the Benefits.* Report of the Expert Panel on the Commercialization of University Research Presented to: The Prime Minister's Advisory Council on Science and Technology, May 4, 1999.

become self-sufficient, but are necessary components of a successful innovation and commercialization process. These include:

(i) The university R&D dissemination function,
(ii) SME applied R&D; and
(iii) Industry sector applied research alliances (which should not be self-sufficient if they perform the required social investment innovation functions of a strong innovative economy).

- At present, public sustained social investments are limited to the following:
  (a) The R&D granting councils provide sustained social *basic* R&D investments.
  (b) NRC invests in federal basic and applied R&D and provides grants to small and medium-sized enterprises (SMEs) via IRAP (without requiring self-sufficiency, repayment, intellectual property or other economic return on invest nent (ROI) to the funding agency (NRC).

- Sustained social investments should not and cannot be made under the requirement of self-sufficiency in the early stages of the innovation process, if these service functions are to be effective. In industry sectors, some of the social investments may be made in partnership with industry.

- Public investments (university and federal/provincial) in R&D typically result in one innovation per $1 million of R&D, and average financial return on dissemination of this intellectual property approximates 1-2% of the R&D investment.

- As long as the intellectual property arising from this public R&D investment benefits local and national industry, it should be made readily available to industry without impediment. The returns to the university from licensing IP are very low, and much lower than the financial benefits and research activity arising from strong university/ industry relationships that employ the intellectual property.

- Industry liaison and dissemination services should be considered a sustained social investment that accompanies R&D investment, and is undertaken in order to derive social/economic benefit from the R&D investment. Expenditure of 5% of R&D budgets on these services typically results in a one to two percent return.

- Present Atlantic industry (applied) R&D represents one percent (1%) of the national level of industry R&D in all of Canada. This is not a *critical mass* level, and this low level contributes to the significant innovation R&D ratio imbalance with respect to the level of university R&D in the region.

- In order for Atlantic Canada's R&D ratios to transition towards those of a more innovative economy with a 2:1 (or better) industry/university R&D ratio equal to the Canadian average, the level of Atlantic *industry* R&D must increase significantly.

- Atlantic in'ustry funds $89 million and performs $95 million in R&D. Approximately 6% ($6 million) is leveraged from other federal programs (largely NRC/IRAP). However, the Canadian average leverage of industry R&D is 26% and ranges from $6.8 billion to $9.1 billion, or $2.3 billion more annually.

- While there is substantial federal/provincial innovation program support, Atlantic Canada is unable to exercise and leverage it, in part due to small industry investment levels.

- However, where the matching opportunity is local and focussed (as for NRC/IRAP), Atlantic Canada matching is 13.8% or almost 2 times the national average – a very positive Atlantic strength.

- In the absence of a strong university/industry liaison investment commitment in the region, and in spite of the very low levels of industry funded R&D (at $89 million compared to $6.8 billion in Canada), Atlantic industry funding of university research is almost at the 11.8% Canadian average. This is another positive sign for cooperative research relationships.

- Successful clusters have an R&D profile that favours a high industry/university R&D ratio. The industry portion is comprised of applied R&D for product applications in numerous SMEs and in industry pinnacles of strength, while university contributions conduct basic R&D and advance the core or platform R&D as the underpinning of innovation advancements.

- The Atlantic region has few significant sources of applied R&D investment (other than NRC/IRAP) via other agencies or applied R&D science councils (as in other Provinces).

- There are only a few Atlantic examples of applied R&D alliances and pinnacles of strength in sectors that integrate across much of the innovation spectrum. They are not (and should not try to be) self-sufficient, but should require sustained partnership investment with industry. They (e.g. Genieo and TARA) provide a social service with approximately 50% of their function (but do not have sustained social investment for this). The other 50% is used for mentoring, pre-seed and seed investment. Replication of elements of the structure and activities of these types of agencies is required in other emerging sectors.

- Best practices from other jurisdictions (e.g. BC Advanced Systems Institute) suggest appropriate investment ratios across the innovation spectrum, and in sector alliances and emerging clusters should be:
  i) 10 - 20% awareness/networking;
  ii) 10 - 20% student/university applied research expertise;
  iii) 20% applied research; and
  iv) 40 - 50% pre-seed/seed and industry mentoring.

- Transition towards a more innovative economy will require:
  a) Sustained social investments in the early stages of the process;
  b) Significant increases in leverage and matching of existing (and incremental) industry applied R&D investments;
  (c) Positive tax regimes;

(d) Sustained social investments in awareness, networking, students and applied R&D for SMEs and
(e) Stronger university/industry R&D relationships with major increases in industry directed R&D during transition to stronger industry internal R&D and commercialization receptor capacity.

- While sustained social investments and public private partnership investments support transition of the economy to 60%+ industry applied R&D, university research strengths will have to play an important role in increases in collaborative levels of applied R&D in the next few years.

- An additional $330 million per annum in industry-performed applied R&D would help rectify the imbalance with the rest of Canada and the U.S. in terms of industry- vs. university-performed R&D. This amount equals one-half of the Atlantic's 7.7% per capita *pro rata* proportion of national R&D. In order to achieve this target over the next five years, the AIF and other funding sources would have to focus on activities that support industry-directed applied R&D conducted in partnership with universities.

Section 6: Conclusion & Next Steps

Change is necessary in order to strengthen Atlantic Canada's economy and insulate it from market fluctuations and the problems of scarcity associated with a natural resource based economy. Innovation and commercialization are becoming increasingly important to the sustainable future of this region.

The four provinces of Canada's Atlantic region face several challenges in achieving their competitive potential. This research report offers observations and analysis of the region's innovation and commercialization landscape, with particular emphasis on the links to research facilities and post-secondary institutes in the region. It is another step in the process of developing a strategy for capitalizing on innovation and commercialization activities as a means of generating widespread economic development in Atlantic Canada. There is much to do.

6.1 Developing a Strategy

"'Innovation' is a concept which defines significant change as beneficial...Innovation requires risk taking."[61] While the first part of this statement is generally accepted by all the participants and stakeholders interviewed in this study, it is the willingness to take risks to create the conditions conducive to a competitive innovative economy that is among Atlantic Canada's most important challenges. There are five main contributors to a region's overall innovative performance and global competitiveness. These are:

1. Common innovation infrastructure that supports innovation in the economy as a whole;
2. Cluster specific conditions that support innovation in particular groups of interconnected industries;
3. Strong linkages among them;
4. Supportive regulatory, fiscal and taxation issues;[62] and
5. People with both the ability and the motivation to drive activity and achieve results.

Innovation and knowledge-based enterprise must become major aspects of a sustainable Atlantic economy. As such, specific policies should be implemented within a strategic model as reflected in business plans and implementation plans. These should represent the overall Atlantic region needs in the context of a regional approach, but with specific areas of expertise or sector focus allocated according to the strengths of the individual provinces or research sectors within the provinces.

A strategy for economic development and innovation in Atlantic Canada should include many of the same elements as those in an effective business strategy or competitive

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[61] *Policy Innovation in the Saskatchewan Public Sector*, 1971-8, Eleanor D. Glor, ed. Toronto: Captus Press, 1997, pp. 3-4.

[62] *Total Development Fund: R&D/Innovation Strategy*, Department of Business, New Brunswick, OECD Innovation Capacity, June 28, 2001.

strategy. In order to develop an appropriate and effective competitive strategy, research institutes, agencies and provincial governments throughout the region must first identify and agree on key areas of strength or skills and assets in which to focus efforts. Secondly, they must determine appropriate levels of investment, costs, sources of funding and feasibility of expanding the skills and assets that will provide the basis for a sustainable competitive advantage (SCA).[63] "Functional area strategies"[64] are also needed for various aspects of the innovation and commercialization process, especially applied research, dissemination and industry/university relationship building.

Establishment of a sustainable competitive advantage (SCA) implies that the region is competing — and this it must do. It must compete with other regions of Canada to attract both funding and industry investment and partnership, and it must compete with the U.S. and other international markets. Competition within the region may only weaken Atlantic Canada's ability to develop a SCA, however, because without cooperation in this initiative, the region lacks the critical mass of population, skills, industry and dollars to be competitive on the world market. Allocation of resources — people, infrastructure and financial — must not be spread too thinly. A competitive strategy in Atlantic Canada must be both focused and synergistic. "It is only logical that multiple organizations that can achieve synergistic effects will have an advantage over those that ignore or fail to achieve this strategy."[65] Cooperative efforts and synergistic effects can result in "the creation of value by having businesses that support and complement each other."[66]

The need for cultural change towards a more innovative economy deserves serious attention. According to Jack Welch, the former CEO of General Electric, "Companies desperately need entrepreneurial spirit and new thinking,"[67] This is true everywhere, and Atlantic Canada is no exception. While greater industry receptor capacity is critical, it may be incumbent on universities to help produce and educate the entrepreneurs and business operators of the future. People resources are by far the most important assets in which Atlantic Canada should focus its investment, with strong policies and effective initiatives assisting transition to a more innovative culture.

6.2 Feedback and Discussion

Devising an innovation and commercialization strategy for a nation, a region, or a province is a very complex social, economic, technical and political challenge. This work analyzed existing resources, strengths and weaknesses and to place these in the context of a common perspective for an integrated innovation and commercialization process.

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[63] Aaker, David A., Strategic Market Management, 4th Edition, John Wiley & Sons, Inc., New York, USA, 1995.
[64] Aaker, David A., 1995.
[65] Aaker, David A., 1995.
[66] Aaker, David A., 1995.
[67] Welsh, Jack as quoted in UCLA EMBA article "Welch Offers Insights, Inspiration -- Management Guru Tells It 'Straight from the Gut'" Association of University Technology Managers (AUTM): http://www.autm.net/index_ie.html and http://patron.ucop.edu/ncd/ncd.html, October 2001.

The study sought inputs from Atlantic residents and stakeholders in the process as the information collection and analysis proceeded. It now seeks to have these same stakeholders review the materials that have been assembled to determine if there are common views on types of measures and levels of activity to be taken to facilitate greater economic development via innovation and commercialization.

6.3 Proposed Next Steps

- Analyse the existing makeup and the gaps in industry receptor and performer capacity in each province and in the region collectively. Evaluate the extent to which problems are cultural, and/or related to a weaker entrepreneurial business climate in Atlantic Canada, and/or related to size or to inadequate R&D funding within existing businesses.

- Identify and evaluate the pinnacles of strength to select a few target areas of focus for investment. Use an inclusive process in order to garner greater acceptance and stakeholder 'buy-in'.

- Inventory the assets and strengths throughout the 4 provinces in order to identify locations for (physical) clusters and appropriate organizational alliances and partnerships.

- Set targets for growth of industry capacity and identify sources of funding. It is unlikely that Atlantic Canada's industry capacity could increase over the next five years to 7.7% (in keeping with their percentage of the population) as that is an increase of $655 million per year over a $520 million base. However, it may be possible on a ten-year time scale.

- Review the various economic development and social assistance investments and funding programs regionally and provincially to identify sources of financing and programs that can contribute to the development of an integrated innovation and economic capacity, especially for the KBE portion of the economy.

- Identify social and economic programs, policies and activities that can better foster partnerships and alliances. Establish scenarios, options and plans for developing and implementing these programs and policies.

- Identify cultural strengths and gaps, in order to target key areas for developing more programs to train and support entrepreneurs, new business development and other initiatives that foster a climate of innovation and commercialization.

- Review tax regimes in each of the 4 Atlantic provinces as well as in the region in order to identify specific ways to make them more competitive with other Canadian provinces and internatio..al jurisdictions.[68] Tax incentives are a very

[68] Tax program issues for consideration are noted in reports by New Brunswick and ACOA.

important tool to assist in building SME receptor capacity and to attract more industry investment both from within and from outside the region.

- Integrate these findings and elements into a Draft Discussion Document containing a Pan Atlantic Innovation and Commercialization Strategic Model, a Business Model, Policies and Work Plans for implementation regionally and Provincially.

Appendix A: References

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